

Review of spectral lighting simulation tools for non-image-forming effects of light

M Gkaintatzi-Masouti, J van Duijnhoven, M P J Aarts



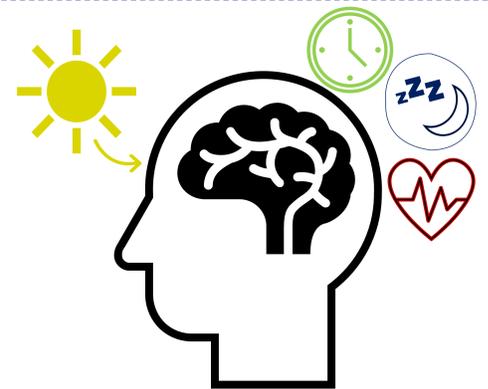
m.gkaintatzi.masouti@tue.nl

INTRODUCTION

Light affects our circadian rhythms and alertness through the non-image-forming (NIF) pathway. To design buildings that take this into consideration we need lighting simulation tools that consider the spectral power distribution (SPD) of light sources and the spectral properties of materials.

This poster presents two aspects:

- 1) A systematic literature review on the methods used for NIF light simulations in buildings focusing on SPD of light sources and spectral properties materials
- 2) A review of existing spectral rendering software that could potentially be useful for NIF light simulations



METHODOLOGY

1) Systematic literature review

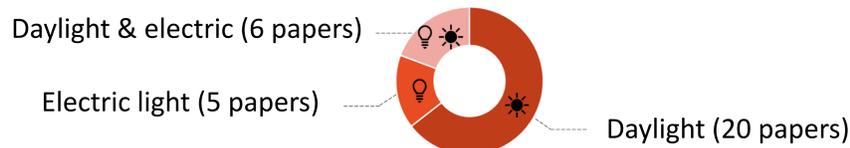
- Databases: Web of Science, Scopus, Science Direct
 - Keywords: “light”, “non-image-forming”, “simulation”, “building design” and synonyms
- Included: 31 papers

2) Review of spectral rendering software

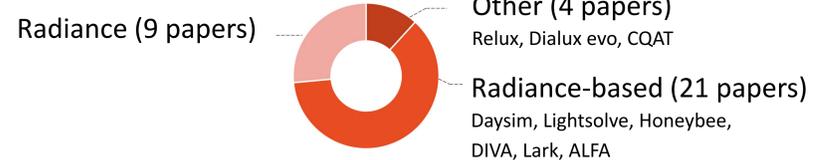
- Spectral rendering software found through review of Jakica [1] and tested.
- Included: 15 spectral rendering tools

1) RESULTS OF LITERATURE REVIEW

Light sources:

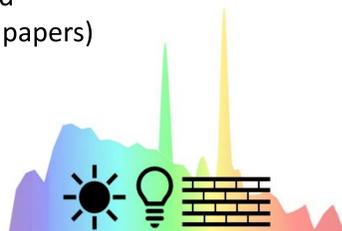


Software:

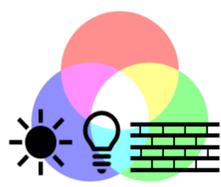


Four simulation approaches to include spectral data:

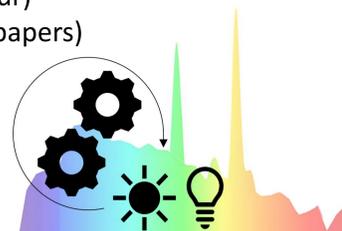
(a) multi-spectral simulation, in which SPD of light source and spectral properties materials are used (12 papers)



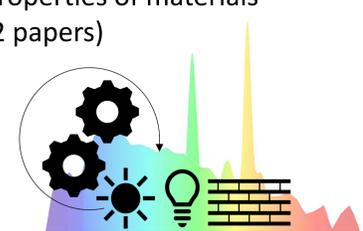
(b) RGB simulation, in which the RGB colour triplets of light source and materials are used (4 papers)



(c) post-processing photometric quantities based on SPD of light source (ignoring materials' colour) (13 papers)



(d) post-processing photometric quantities based on SPD of the light source and the spectral properties of materials (2 papers)



2) RESULTS OF SOFTWARE REVIEW

Two of the tools are useful because they give spectral radiance/irradiance as a result.

Software	License	Daylight	Electric light	Output as image	Output as spectrum
Ocean	Paid	Yes	Yes	Yes	Yes
Mitsuba	Free	Yes	No	Yes	Yes

Additionally, 13 other tools that do not give spectral radiance/irradiance as a result (see our paper [2]).

CONCLUSIONS

Most studies use Radiance or Radiance-based tools, but new user-friendly tools could employ existing spectral rendering software.

However, there are obstacles to this:

- Accuracy is uncertain
- Lack of validation
- (for commercial software) lack of transparency

Our future work will identify gaps in simulations of non-image-forming effects of light and discuss how to include them in building design.

REFERENCES

- [1] Jakica N 2018 State-of-the-art review of solar design tools and methods for assessing daylighting and solar potential for building-integrated photovoltaics *Renewable and Sustainable Energy Reviews*
- [2] Gkaintatzi-Masouti M, van Duijnhoven J, Aarts M P J 2021 Review of spectral lighting simulation tools for non-image-forming effects of light in *CISBAT* (Lausanne)